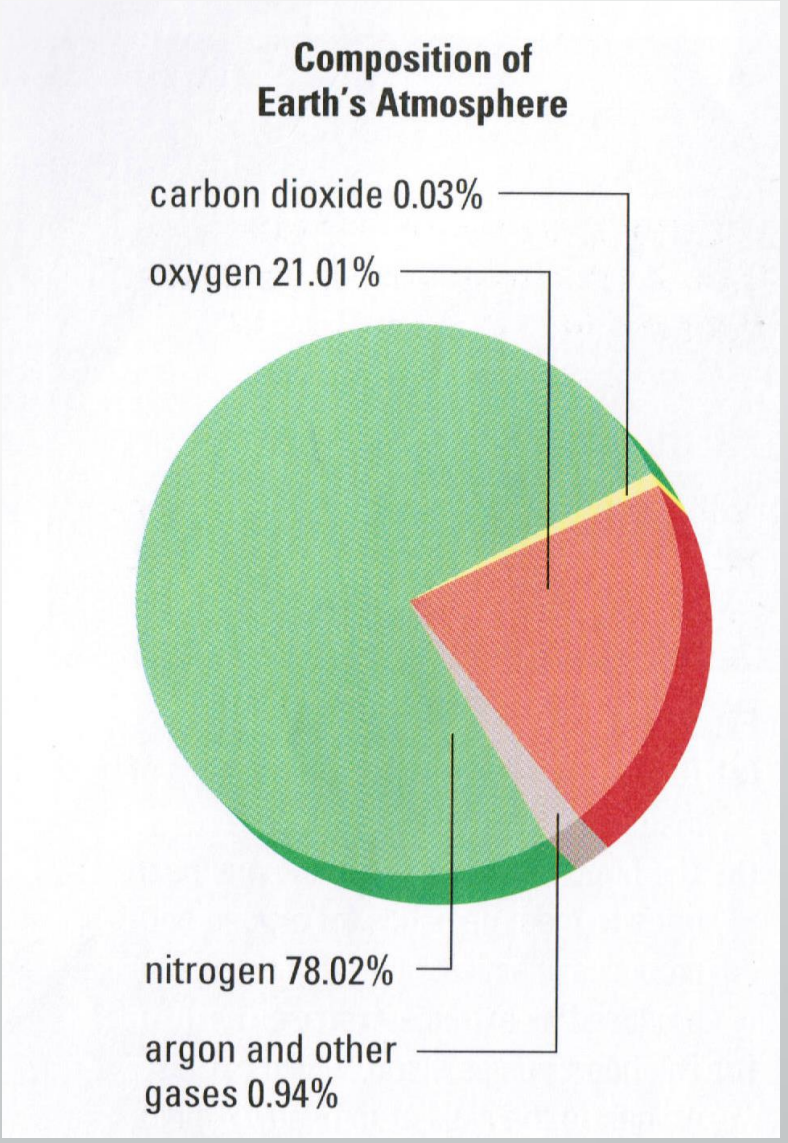
5.1 Respiration - Introduction

You live in a sea of air!

- Nitrogen, oxygen, carbon dioxide, and trace gases are taken into and expelled from your body with every breath.
- Atmosphere 78% nitrogen and 21% oxygen.
- Remaining gases – argon, carbon dioxide and others 1%.



- The second most common component, oxygen → vital to life.
- Cells obtain energy through a chemical reaction called **oxidation**, in which organic compounds are broken down using oxygen.
- Larger the animal → the more oxygen is needed to fulfill its energy needs.

The Need for Oxygen

- Breathing is the act of inhaling and exhaling air – why do we do it?
- We breathe to bring oxygen into contact with specialized tissue that maximizes the transfer of oxygen into our body.
- Oxygen is vital for creating the energy your cells need to survive.

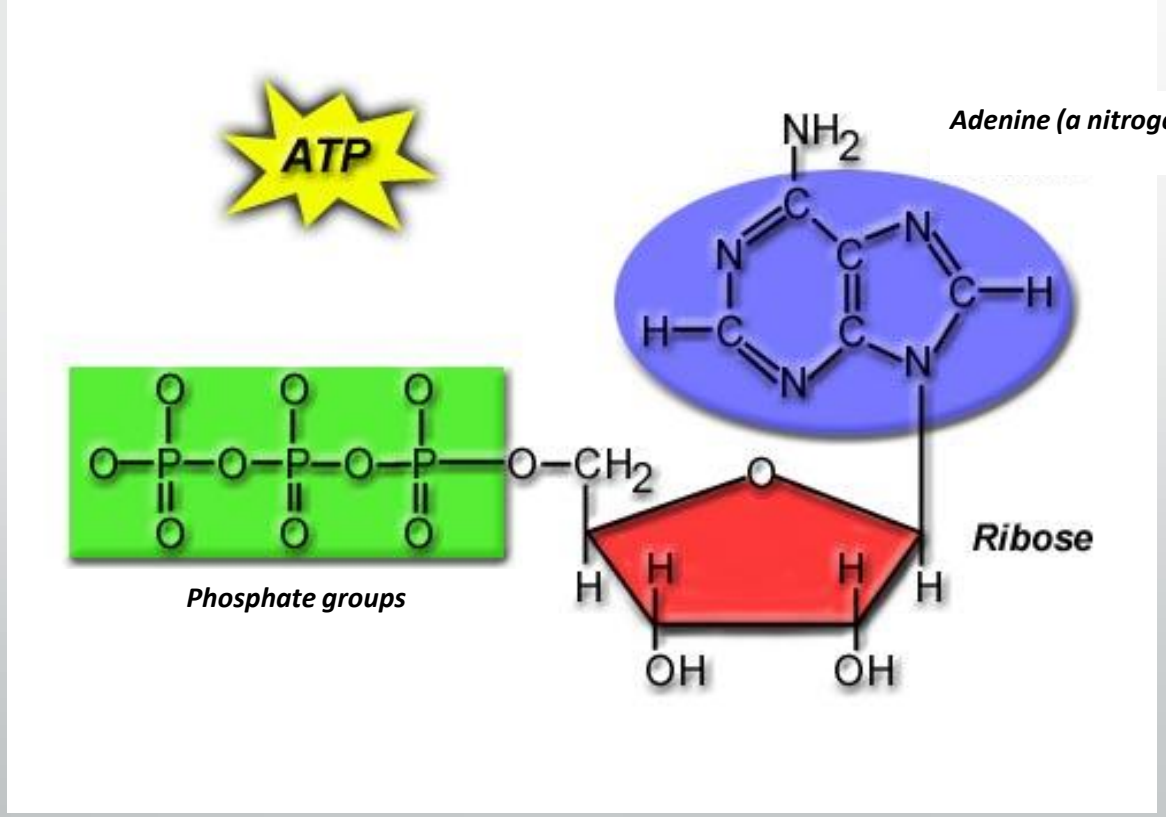
1. Aerobic cellular respiration – process of obtaining needed energy from the chemical reaction of glucose and oxygen. It occurs in the mitochondria.

$$C_6H_{12}O_6 + 6O_2 \xrightarrow{\text{enzymes}} 6CO_2 + 6H_2O + 36\ ATP$$

glucose from food	into lungs	out from lungs	sweat breathed out urinated reused	used for growth reproduction movement

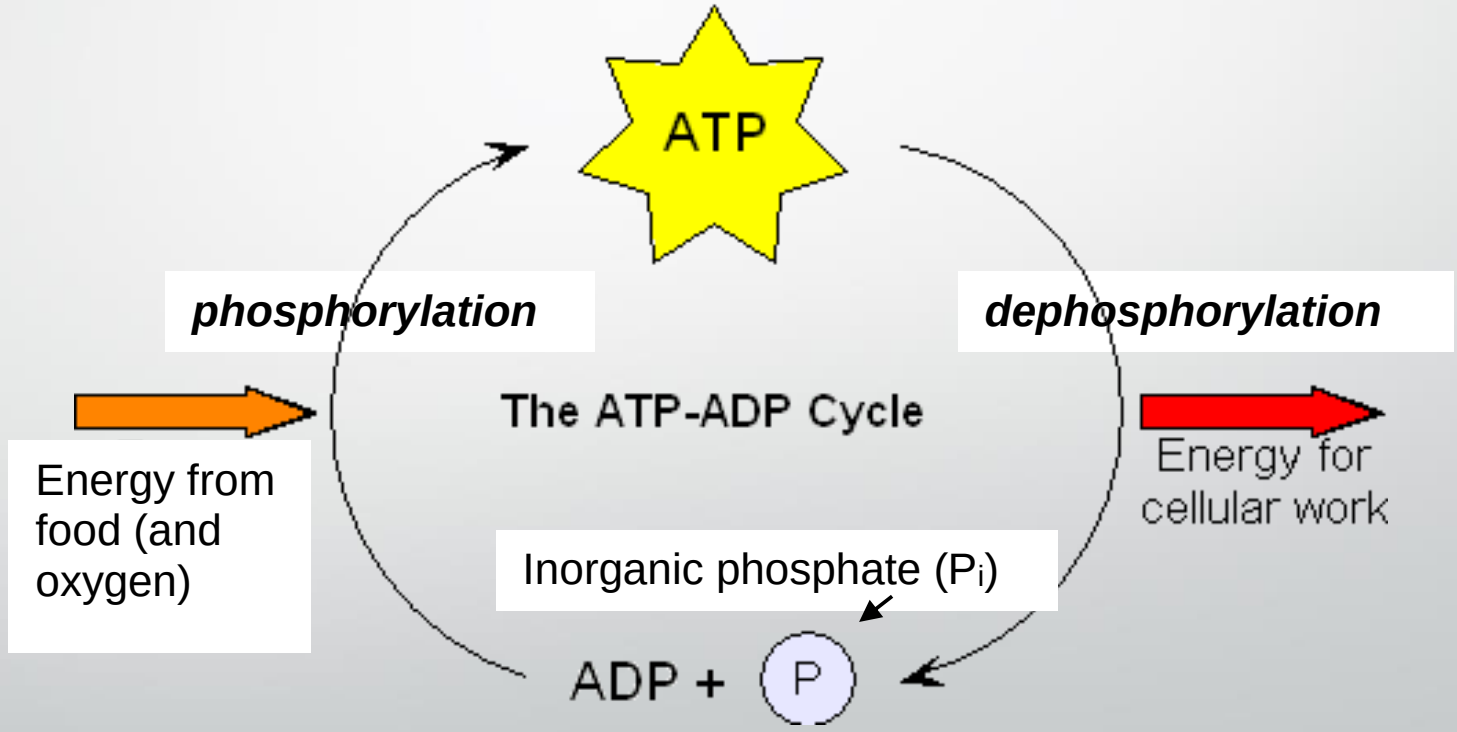
animation

Most energy is 'lost' as heat, ~36% is used to make adenosine triphosphate (ATP)



- ATP is made using the energy derived from the breakdown of glucose, usually in the presence of oxygen – the energy from this reaction drives the phosphorylation of ADP to make ATP

Phosphorylation: the addition of a phosphate group to a molecule; in aerobic cellular respiration the phosphate group is added to ADP, creating the ATP molecule in which energy is stored



2. Gas exchange – The exchange of carbon dioxide and oxygen molecules between external (air we breathe) and internal environment (blood in capillaries).

Single celled organisms

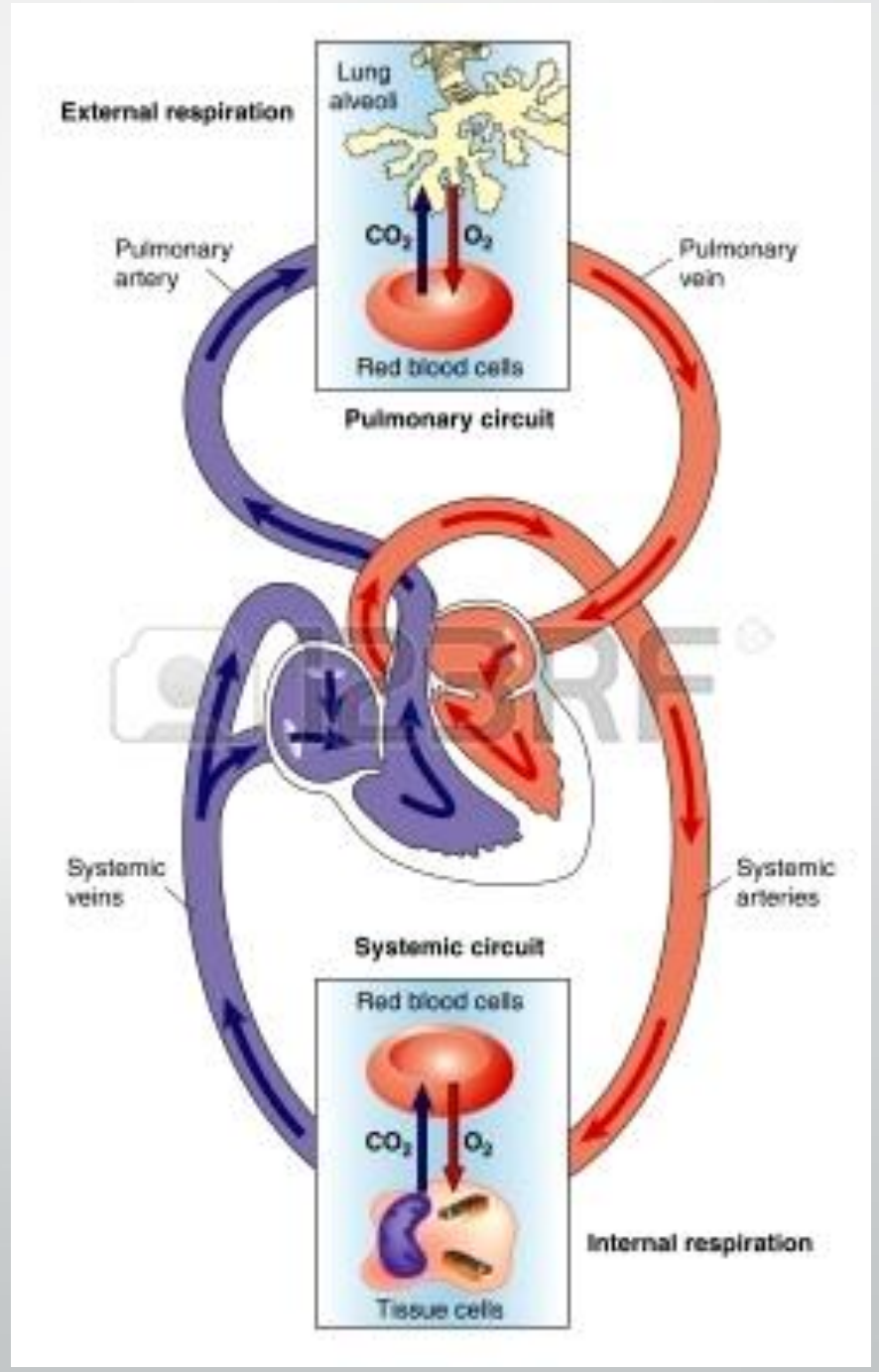
- such as an amoeba, or simple multi-celled animals such as jellyfish, oxygen diffuses from the environment into the cell(s), and carbon dioxide diffuses out. [Understand diffusion]
- Diffuses directly from the surrounding environment through the cell membrane into the cell.

Complex multicellular organisms

- require specialized gas exchange tissue to maximize the diffusion of oxygen and carbon dioxide.
- In human and mammals, gas exchange occurs at two locations → the lungs and the body cells.

The path of oxygen:

- Enters lungs → picked up by RBC and carried throughout the body → leaves RBCs→ dissolves into interstitial fluid → diffuses into the cells and used to make ATP by that cell.
- **Carbon dioxide follows the reverse path.**



3. Ventilation – the movement of air in and out of the lungs.

Gas Exchange in the Alveoli

- By the time air reaches the alveoli, it is at normal body temperature (~37oC), and is saturated with moisture
- The respiratory membrane that forms the alveoli is also moist.
- Moisture is critical since oxygen cannot diffuse across the respiratory membrane unless it is dissolved in a liquid.
- Respiratory membrane is extremely thin (little distance between air and blood)
- O_2 and CO_2 can easily diffuse across the membrane
- The alveoli are encapsulated with a network of capillaries

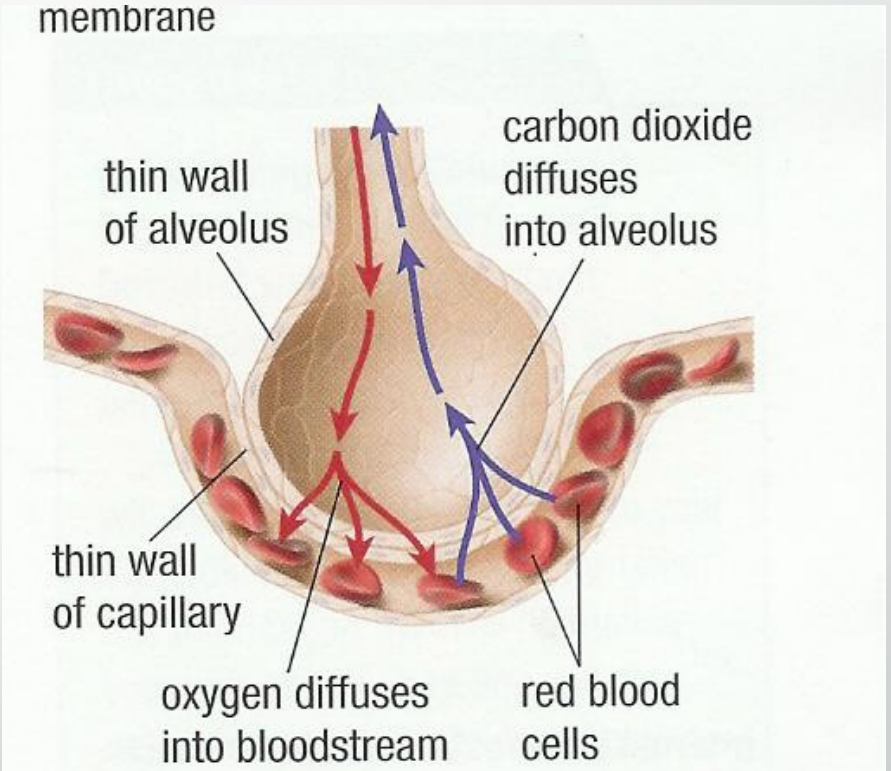


Figure 3 Only two cell layers separate the air in the alveolus from the bloodstream.